§26. Neutral Particle Transport Analysis Using Mulch-chord Hα/Dα Detector Array System in Heliotron J

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In magnetically confining plasma devices, investigation of neutral transport is an important subject for understanding edge plasma behavior and for the estimation of particle confinement characteristics. In especially, quantitative estimation of particle fueling by advanced gas puffing using Super Molecular Beam Injection (SMBI) is key subject not only to clarify the physical mechanism of the fueling but also to develop the control scheme for high performance plasmas. The objective of this study is to clarify the characteristics of the particle fueling by SMBI in Heliotron J.

The Hα/Dα lime emission profiles have been measured using the multi-chord Hα/Dα-line emission measurement system installed in Heliotron J[1]. Figure 1 shows the schematic view of the Hα/Dα detector system and the SMBI systems[2]. Multi-sightline of the Hα/Dα detector system covers the same plasma cross-section as the SMBI beam-line, which enables us to measure the profile of Hα/Dα emission precisely[2]. The cutoff frequency of this system is around 100 kHz. The SMBI system is equipped in the outer torus side and uses fast piezoelectric-type valve. The working gas of SMBI is Hydrogen and the plenum gas pressure can be changed up to 1 MPa.

Figure 2 shows the temporal- and spatial-evolution of the Hα/Dα-line intensity in the case of the plenum pressure and pulse width of (1.0 MPa / 50 μs; high puffing case) and (0.5 MPa / 35 μs; low puffing case). The peak position of the Hα intensity shifted inwardly after SMBI injection. The mean velocity by the movement of the peak position was calculated to be 1.2 km/s for the high puffing case. In this case, the amount of the fed gas was effective to increase the density from 1.0 to $1.8\times10^{19}\ m^{-3}$. In the low puffing case, on the contrary, the mean velocity was 3.6 km/s, which was faster than the high puffing case. Although the reason is not clear, the effect of the motion of the electrons or ions ionized in the peripheral region due to SMBI should be considered in conjunction with the operating characteristics of the piezoelectric valve. Note that the electron density of the main plasma was insensitive to SMBI in the low puffing case, which indicates the amount of the fed gas was expected to be small.

1) S. Kobayashi et al., Rev. Sci. Inst. 77, 10E527 (2006)
2) T. Mizuuchi et al., Proc. 17th Int. Stellarator/Heliotron Workshop, 12 - 16 October, (2009), Princeton, P01-17

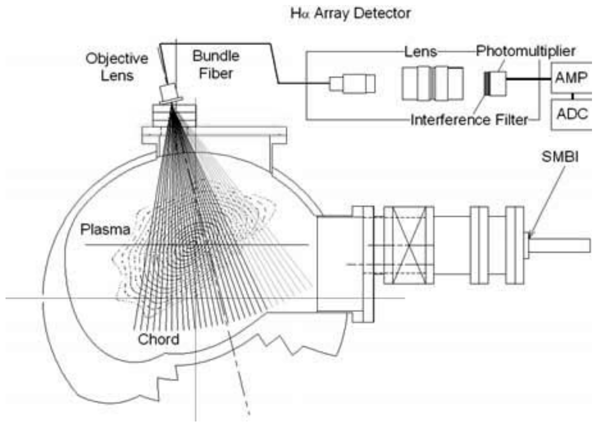

Fig. 1 Schematic view of multi-chord Hα/Dα-line emission detector system and SMBI system in Heliotron J.

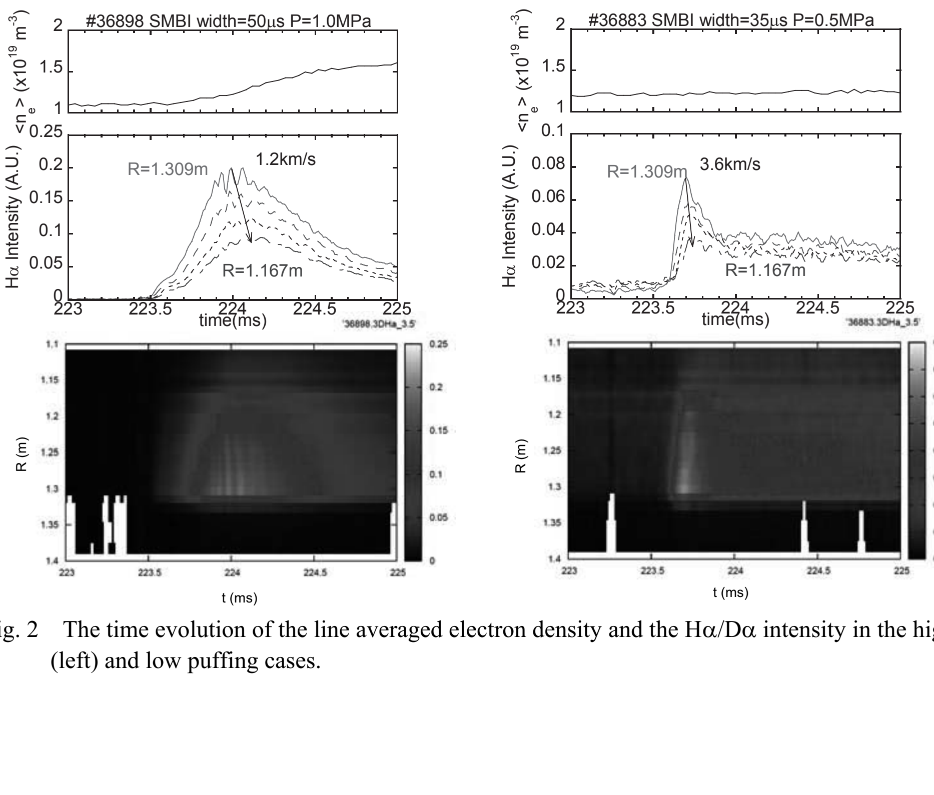

Fig. 2 The time evolution of the line averaged electron density and the Hα/Dα intensity in the high (left) and low puffing cases.